

**Response Under 37 CFR 1.116**  
**Expedited Procedure**  
**Examining Group 1753**  
Appl. No. 10/522,461  
Amdt. dated August 13, 2007  
Reply to Office Action of March 14, 2007  
Attorney Docket No. 1455-050205

**Amendments to the Drawings:**

The attached sheets of drawings include changes to Figs. 2 and 3 to amend measurement numbers to coincide with those set forth in the specification.

Attachments: Replacement Sheets  
Annotated Sheets Showing Changes

## **REMARKS**

### In the Drawings

Applicants have amended Figs. 2 and 3 to correct the measurement numbers as set forth in the specification. No new matter has been added. The amended notations are supported in the present specification on page 6 lines 12-14 and on page 7 lines 10-11.

### In the Specification

Applicants have amended a paragraph on page 6 of the specification to correct a typographical error in that "6" should read "7". Support for this amendment may be found in the beginning of that paragraph and elsewhere in the specification. No new matter has been added.

### In the Claims

Claims 1-12 are pending in the application.

Claim 2 has been objected to in that "photon" should read – photons --. Applicants have amended claim 2 as required by the Examiner.

Claim 3 has been rejected in that the Examiner states it is unclear whether the "said atoms of thallium" is the same as the plurality of ground state thallium atoms recited in claim 1. In addition, the Examiner points to the photons of the first frequency pump ground state thallium atoms as recited in claim 1, which is different from the photons of the first frequency pumping non-ground state thallium atoms. Clarification has been requested.

Applicants affirm that the Examiner's understanding is correct. The phrase "said atoms of thallium" are the same as the plurality of ground state thallium atoms recited in claim 1 at line 2. In fact, according to the present invention, the photons of the first frequency pump the ground state thallium atoms into a metastable state through an excited state.

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With regard to claim 12, the Examiner questioned whether claim 12 has been canceled. Applicants have canceled claim 12 herein.

**Claim Rejections under 35 U.S.C. §103**

Claims 1-12 stand rejected under 35 U.S.C. §103(a) as being unpatentable over French Patent No. 2,790,974 to Scheibner (Scheibner) in combination with U.S. Patent No. 5,221,446 to Eerkens (Eerkens). Applicants had previously asserted that Scheibner uses the field ionization method, while in the present invention the target isotope is photoionized by using IR lasers. The Examiner asserts, in response, that Scheibner teaches a photoionization method, citing the description "la figure 5 est une illustration des trajets de photo-ionization pour le thallium qui sont utilises dans la present invention".

In addition, the Examiner asserts that the claims as presently written do not specifically recite using IR lasers and that limitations are not read into the claims without a proper claim basis therefor.

In response, Applicants assert that the term "photo-ionization" in the Scheibner method is considered to have been misunderstood from the point of view of technical terminology as well as the technical elements thereof.

As to the technical terminology, according to the encyclopedia 'wikipedia', the scientific term "photo ionization" is defined as: "the physical process in which an incident photon ejects one or more electrons from an atom, ion or molecule", and the scientific term "photo excitation" is defined as: "the mechanism of electron excitation by photon absorption, when the energy of the photon is too low to cause photoionization. The absorption of photon takes place in accordance to the Planck's Quantum Theory."

According to the present invention as defined in independent claim 1, the photons of the first frequency pump (excite) isotope-selectively the atoms of thallium ( $Tl^{203}$ ) from the ground state through an excited state (for example, at an energy of  $26477.6cm^{-1}$ ) into a metastable state (for example, at an energy of  $7793cm^{-1}$ ) (referred to as "the first step"), and the photons of the second frequency

pump (excite) a plurality of metastable state thallium atoms to an intermediate resonant state (for example, at an energy of  $42049.0\text{cm}^{-1}$ ) (referred to as “the second step”), and then the photons of the third frequency ionize a plurality of atoms in intermediate resonant state (referred to as “the third step”).

As shown in the above description, in the first step and second step the thallium atoms are selectively excited (pumped) by a laser system from the ground state to the intermediate resonant state through the metastable state. In the first two claimed steps, the thallium atoms are not ionized, but excited. Thus, those steps (the first step and the second step) could be called “photoexcitation steps”.

In the third step of the present invention, the selected thallium atoms in the intermediate resonant state are ionized by applying the photons of the third frequency. Thus, the third step could be called a “photoionization step”. Therefore, it could be said that the present invention uses a photoionization method in which the target isotope is photoionized by IR lasers.

On the other hand, according to Scheibner, which corresponds to Japanese Laid Open Patent 2000-262,866, the photons of the first frequency (around 377.7 nm) excite isotope-selectively the atoms of thallium ( $\text{TI}^{203}$ ) in the ground state to an intermediate quasi-resonant state (at an energy of near  $26477.5\text{cm}^{-1}$ ) (referred to as “the first step”),

the photons of the second frequency (around 445 nm) excite the atoms of thallium-203 ( $\text{TI}^{203}$ ) in the intermediate quasi-resonant state to a final Rydberg state (at an energy of near  $49000\text{cm}^{-1}$ ) (referred to as “the second step”),

and then the isotope  $\text{TI}^{203}$  atoms of the Rydberg state are ionized by applying an electric field (referred to as “the third step”).

As described above, the thallium atoms are excited by photons from the ground state to the Rydberg state through the intermediate quasi-resonant state. Thus, the first and second steps in the Scheibner FR '974 patent could be referred to as “photoexcitation steps” which can be considered similar to the first and second steps of the present invention. However, the third step of the FR '974 patent, wherein the thallium atoms in the Rydberg state are ionized by applying an electric

field, could not be called a “photoionization step” but, rather, a “field ionization step”, because in the FR ‘974 invention the thallium atoms are ionized by using or applying an electric field instead of using photons (lasers).

Scheibner clearly states that the thallium atoms of the Rydberg state are ionized by applying an electric field and labeled as “field ionization” (see page 8, line 27 to page 9, line 6, corresponding to JP Laid Open Patent 2000-262866 at page 5, column 0019).

On the other hand, the present invention uses a photoexcitation step to excite atoms and a photoionization step to ionize atoms, while Scheibner uses a photoexcitation step to excite atoms and a field ionization step to ionize atoms. Thus, it is clear that the photoionization process is technically totally different from the field ionization process of the Scheibner method.

In addition, the photoexcitation steps of the present invention differ from those of the Scheibner method in that in the present invention the thallium atoms are excited from the ground state through a resonant excited state (at an energy of  $26477.6 \text{ cm}^{-1}$ ) to a metastable state (at an energy of  $7792.7 \text{ cm}^{-1}$ ) and then to an intermediate, resonant state, while in the Scheibner method the thallium atoms are excited from the ground state to a quasi-resonant state (at an energy of near  $26477.6 \text{ cm}^{-1}$ ) (in Fig. 5 of Scheibner, 502 indicates a resonant excited state and 503 indicates a quasi(not)-resonant excited state, which is below the resonant excited state by  $1 \text{ GHz}$ ) and then from the quasi-resonant state to the Rydberg state.

In conclusion, the present invention clearly distinguishes over the Scheibner method in that (1) for ionization of atoms, the present invention uses a photoionization method, while Scheibner uses field ionization, and (2) even for excitation the present invention and the Scheibner invention differ from the standpoints of excitation energy level and the photo-selective pathway.

The Examiner asserts that Scheibner teaches using a Ti: Sapphire laser (page 12, lines 4-8) which emits near-infrared light tunable in the range from 650 to 1100, and that Scheibner also teaches photoionizing using a laser having the

wavelength of 1064 nm (page 12, lines 9-12). The Examiner goes on to state that the claims as presently written do not specifically recite using IR lasers.

Applicants respectfully disagree and point out that claim 1 of the present invention specifically recites producing photons of a third frequency in the range of 700 nm to 1400 nm to ionize the thallium atoms in the intermediate, resonant state. According to the present invention, the photoionization cross-section was measured for  $7^2D_{5/2}$  using 1064 nm Nd : YAG laser, but as mentioned in the detailed description, "efficient photoionization is expected if an ionizing IR laser with modest power has the wavelength in the range of 700-1400 nm, which corresponds to energy range of  $49266.7 \text{ cm}^{-1} - 55000 \text{ cm}^{-1}$ " (see page 7, lines 15-20 of the instant specification), laser wavelength of 1400 nm which has energy of  $(1/1400 \text{ nm} = 7143 \text{ cm}^{-1})$  is the longest wavelength to excite  $7^2D_{5/2}$  at  $42049 \text{ cm}^{-1}$  to ionization level of  $49266.7 \text{ cm}^{-1}$  and considering the decreasing tendency of photoionization cross-section at shorter wavelength, 700 nm is claimed as the shortest wavelength for photoionization. Therefore, Applicants submit that the claims as presently written specifically recite using IR lasers as "producing photons of a third frequency by said laser system, wherein said third frequency is in the range of 700 nm to 1400 nm."

The titanium : sapphire laser used in Scheibner is for photoexcitation and the IR laser in the range of 700 nm to 1400 nm used in the present invention is for photoionization. Thus, the same IR lasers are used for completely different purposes. This also clearly distinguishes the present invention over Scheibner.

With reference to Nd : YAG laser as disclosed in Scheibner at page 12, lines 9-12 ("L'oscillateur maitre est egalement pompé par des lasers Nd/YAG impulsionnels à doublage de frequence"), the Nd : YAG laser used in Scheibner is for pumping the master oscillator of titanium: sapphire laser to generate the titanium: sapphire laser. In other words, the Nd: YAG laser in Scheibner is a part of the titanium : sapphire laser used for photoexcitation.

With reference to exciting the thallium atoms to the Rydberg state, the present invention does not, in fact, use a Rydberg state and does not use a single frequency pulse laser having narrow line width to excite the ground state thallium

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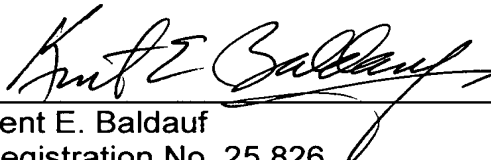
atoms to the intermediate excited state ( $26477.5 \text{ cm}^{-1}$ ), and Applicants assert that none of the pending claims recite this type of operation.

Claims 6-8 of Scheibner disclose a process wherein a single frequency pulse laser having narrow line width excites the ground state thallium atoms to the intermediate excite state (near  $26477.5 \text{ cm}^{-1}$ ), and the thallium atoms transferred to the metastable state are excited twice with pulse lasers through another intermediate state (near  $36,199.9 \text{ cm}^{-1}$ ) to the Rydberg state at the energy level of about  $49000 \text{ cm}^{-1}$ . On the other hand, the present method excites the ground state thallium atoms to the intermediate excite state ( $26477.5 \text{ cm}^{-1}$ ) using a narrow bandwidth continuous wave (CW) laser, and then the excited thallium atoms are transferred to the metastable state ( $7793 \text{ cm}^{-1}$ ), and then excited twice with two pulse lasers with no restriction on linewidth to the final excite state ( $42049 \text{ cm}^{-1}$ ) which is quite far from the Rydberg state of  $49000 \text{ cm}^{-1}$  used in the Scheibner method. Thus, claims 2-3 of the present invention are deemed to be specific enough that no further limitations are required to distinguish over the Scheibner method.

Applicants respectfully request reconsideration of the Examiner's rejection in light of the foregoing amendments and remarks. The Examiner's reconsideration and favorable action regarding claims 1-11 are respectfully requested.

Respectfully submitted,  
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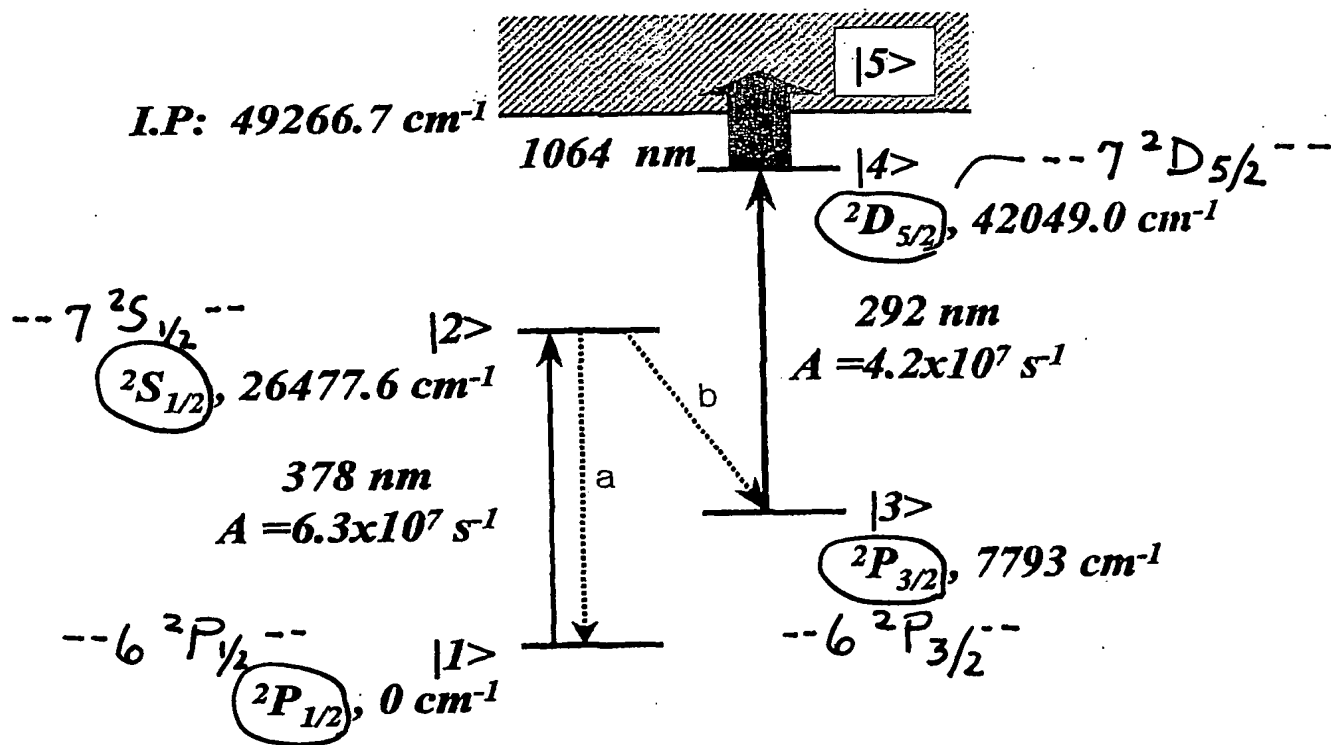
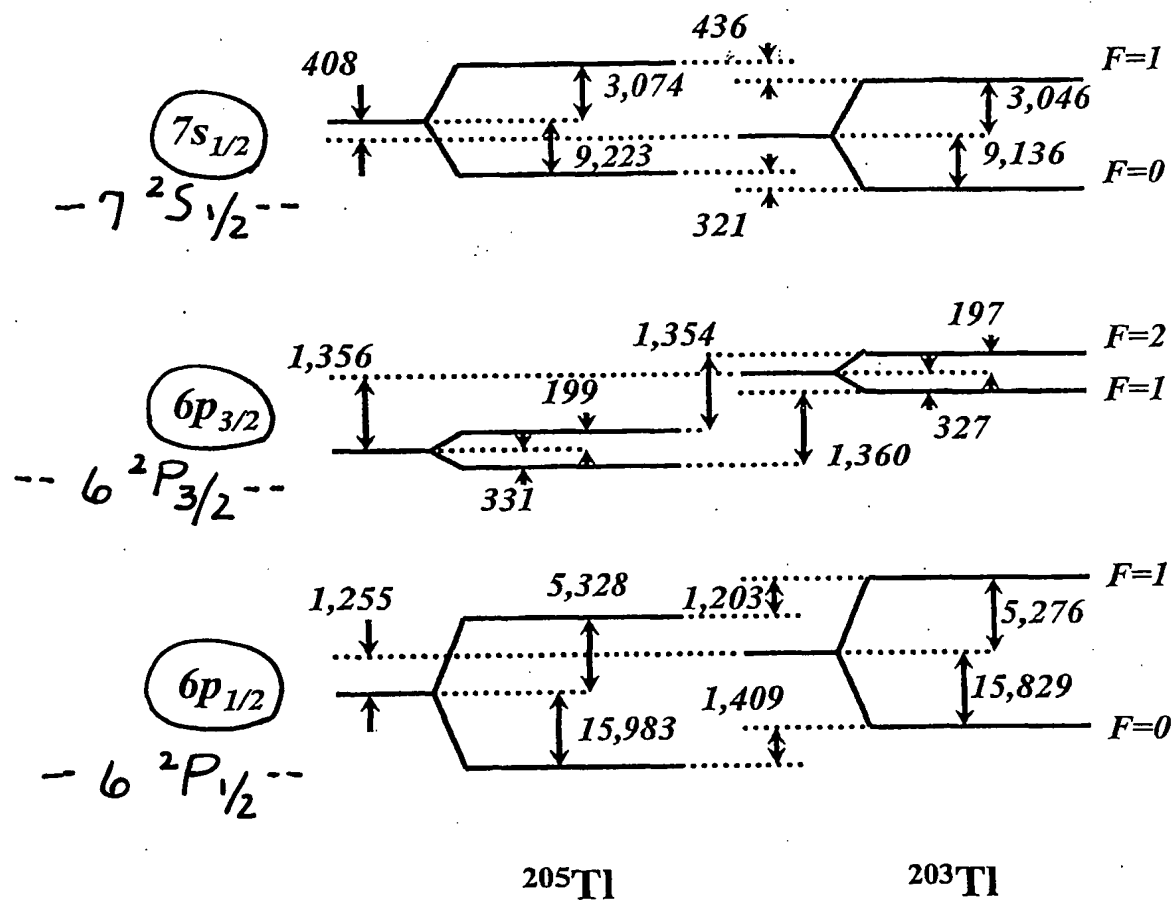


FIG. 2

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(Energy given in MHz)

FIG. 3